Title: The Acidic Reaction Caused by Certain Candies

Brief Overview:

Students will use the pH Probe and the TI-83 Graphing Calculator in conjunction with the CBL Unit to test the acidic reactions of four various candies.

Links to NCTM 2000 Standards:

- **Mathematics as Problem Solving, Reasoning and Proof, Communication, Connections, and Representation**
  These five process standards are threads that integrate throughout the unit, although they may not be specifically addressed in the unit. They emphasize the need to help students develop the processes that are the major means for doing mathematics, thinking about mathematics, understanding mathematics, and communicating mathematics.

  Students will demonstrate and formulate conclusions based on their interpretation and analysis of statistical data. They will demonstrate their ability to solve mathematical problems through experimentation and will investigate and observe the acidic reactions of various candies. Students also will interact in groups to formulate conclusions from observed outcomes. Furthermore, they will utilize mathematical analysis to interpret a graphical representation of a real situation. Last of all, they will design and present a portfolio.

- **Statistics**
  Students will demonstrate proficiency in the utilization of the statistical capabilities of the TI-83 graphing calculator.

Grade/Level:

Grades 9-12

Duration/Length:

This activity will take two class periods. Follow up time should be allowed to discuss outcomes.

Prerequisite Knowledge:

Students should have working knowledge of the following skills:

- TI-83 graphing calculator
- CBL Unit
- Graphing background
- Measurement
- pH values
- Statistics
- TI-Graph Link

Objectives:

Students will be able to:

- collect and organize data.
- evaluate statistical data to compare pH values.
- analyze statistical data to formulate conclusions.
- design a portfolio that will logically support their conclusion.

Materials/Resources/Printed Materials:

- TI-83 Graphing Calculator
- CBL Unit
- Five Styrofoam cups
- TI-Graph Link
- DIN adapter
- pH probe
- Distilled water
- Four varieties of candy
- Pestle/Mortar set
- 100ml graduated cylinder
- Program “CANDY” for TI-83 calculator
- One teaspoon

Development/Procedures:

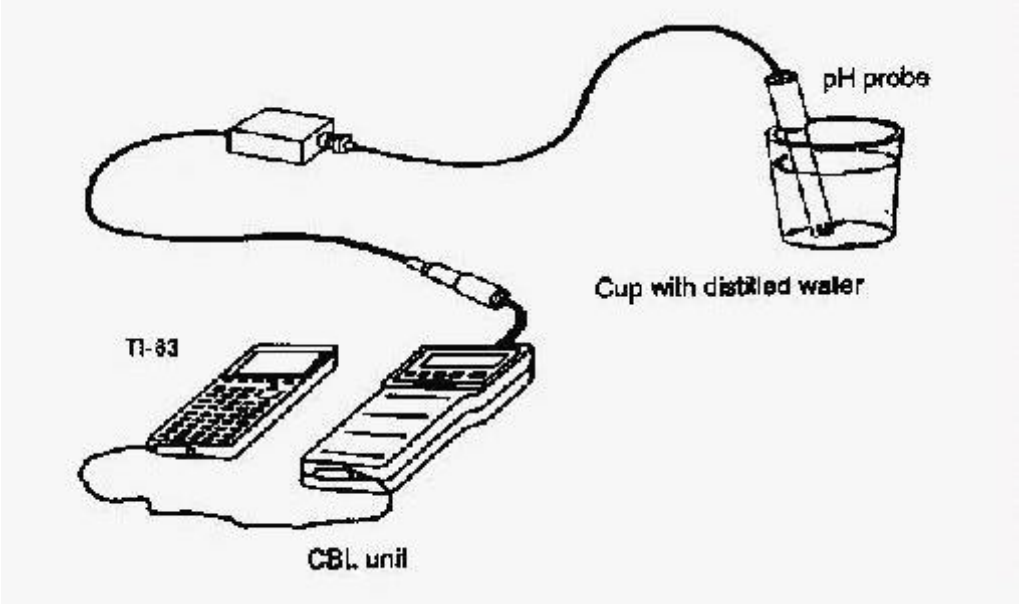

Figure 1

Do in the following order:

1) Assign four students to a group.
2) Each student selects one candy type.
3) Each student completes the experiment.
4) Download program “CANDY” for TI-83 graphing calculator.
5) Connect the TI-83 to the CBL unit using the Graph Link (see Figure 1).
6) Connect the pH probe to the CBL unit using port 1 (see Figure 1).
7) Fill five styrofoam cups with 100ml of distilled water.
8) Designate one cup as a cleansing cup for the pH probe.
9) Turn on TI-83 and CBL unit.
10) Access the program “CANDY” on the TI-83.
11) Activate the program “CANDY” by pressing enter.
12) Follow the instructions on the TI-83 screen to complete the activity.
13) Use the TI- Graph Link to print all graphs.

Assessment:

- Teacher will interact with each group to ensure proper experimentation.
- Teacher will review the activity sheet for completeness.
- Teacher will apply a defined rubric to assess each portfolio.

Extension/Follow Up:

- Students will use own candy to observe levels of pH.
- Students will conduct a pH study on larger quantities of candy.
- Students will generate piece wise graphs.
- Students will determine rates of change.
- Students will taste candy, predict its pH, and compare to actual reading.
- Class will correlate and rank individual results.

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NOTE: Activities/directives are included on the following pages.

Portfolio Design

The portfolio is the final project submitted by each group. It is assessed by a defined rubric and consists of four individual projects with a final cumulative summary.

Individual projects include:

- Name
- One candy wrapper
- One labeled graph
- One written conclusion [question 8 from activity sheet]
- Design left to student

Group portfolio includes:

- All four individual projects
- Final cumulative summary
- Design left to group

Notes to teacher:

- Stress quality work.
- Stress creativity in project and portfolio design.
- Display exemplar.
- Final cumulative summary may utilize a graph, but needs to be in written form.
- Collect individual “CANDY” activity sheets.

Rubric for assessing portfolio:

Assessment	Description	Requirements
1	Excellent	Complete with: • Candy wrapper. • Graph(s) labeled. • Change in pH. • Short written result.
2	Very Good	1 or 2 minor infractions: • No labels. • No conclusion. • Missing one experiment.
3	Good	1 major infraction: • Missing two experiments. • No graphs. • No conclusion.
4	Not Assessable	2 or more major infractions: Totally incomplete.

NAME _____

INDIVIDUAL "**CANDY**' ACTIVITY SHEET

1. Record the name of the candy that you have chosen. _____
2. What types of acids, if any, does your candy contain? _____
3. What was the initial pH value of the candy when t=0? _____
4. If your graph decreased, (or increased), what was the lowest, (or highest) value it reached? _____
5. What was the final pH value for your experiment? _____
6. Calculate the absolute difference between the answers to questions 3 and 5. _____
7. If it applies to your experiment, explain why the lowest, (or highest), pH reading was not the same as the final pH reading.
   _____
   _____
   _____
   _____
   _____
8. In your own words, write a conclusion stating the observed measurable results of your experiment as well as any conclusions that can be drawn. [This conclusion should be part of your individual project.]
   _____
   _____
   _____
   _____
   _____
   _____
   _____

TI-83 CANDY PROGRAM

```
ClrHome
ClrDraw
Normal
Float
Radian
Func
Connected
Sequential
Real
Full
GridOff
PlotsOff
FnOff
AxesOff
Disp "ACIDIC REACTION"
Disp ""
Disp "    CAUSED BY"
Disp ""
Disp "CERTAIN  CANDIES"
Disp ""
Disp "**PRESS[ENTER]**"
Pause
ClrHome
ClrDraw
ClrDraw
ClrHome
Text(1,1,"*")
Text(55,90,"*")
For(I,1,90,5)
Text(1,I,"*")
Text(55,90-I,"*")
End
For(I,1,54,6)
Text(I,2,"*")
Text(55-I,88,"*")
End
Text(10,28,"DESIGNED   BY")
Text(22,22,"MICHAEL   STOVER")
Text(35,45,"AND")
Text(48,24,"CHRIST   GOEBEL")
Pause
Lbl 7
Menu("****OPTIONS****","INSTRUCTIONS",A,"COLLECT
DATA",B,"PROJECT",M,"QUIT",C)
```

```
Pause
Lbl A
ClrHome
ClrDraw
Disp ""
Disp "FILL 5 CUPS WITH"
Disp ""
Disp " 40 MILLILITERS"
Disp ""
Disp "    OF WATER"
Disp ""
""
Disp "**PRESS[ENTER]**"
Pause
ClrHome:ClrDraw
Disp ""
Disp "   LABEL FOUR "
Disp ""
Disp "  OF THE CUPS"
Disp ""
Disp "  A,B,C,AND D."
Disp ""
Disp "**PRESS[ENTER]**"
Pause
ClrHome:ClrDraw
Disp ""
Disp "  USE CUP [A]"
Disp ""
Disp " FOR EXPERIMENT"
Disp ""
Disp "   ONE  [ETC.]"
Disp ""
Disp "**PRESS[ENTER]**"
Pause
ClrHome:ClrDraw
Disp ""
Disp " PLACE PH PROBE"
Disp ""
Disp "   IN THE CUP"
Disp ""
Disp "**PRESS[ENTER]**"
Pause
ClrHome:ClrDraw
Disp ""
Disp "   YOU ARE NOW"
Disp ""
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```
Disp " READY TO BEGIN"
Disp ""
Disp " THE EXPERIMENT"
Disp ""
Disp "**PRESS[ENTER]**"
Pause
ClrHome:ClrDraw
Disp ""
Disp "  SELECT CANDY"
Disp ""
Disp " TO BE ANALYZED"
Disp ""
Disp "**PRESS[ENTER]**"
Disp ""
Pause
Lbl B
Lbl 8
Menu("***CANDY TYPE***","SOFT CANDY",D,"HARD CANDY",E,"POWDER
FORM",F)
Lbl D
AxesOff
ClrHome:ClrDraw
Text(1,5,"****SOFT CANDY*****"
Text(12,12,"1.  OPEN  CAREFULLY")
Text(21,12,"2.  SAVE  WRAPPER")
Text(30,12,"3.  SELECT  4  PIECES  FOR")
Text(39,13,"EXPERIMENT, [USE  ALL]"
Text(52,20,"  PRESS  [ENTER]  ")
Pause
Goto G
Lbl E
AxesOff
ClrDraw:ClrHome
Text(1,5,"****HARD CANDY****"
Text(10,12,"1.  OPEN  CAREFULLY")
Text(19,12,"2.  SAVE  WRAPPER")
Text(28,12,"3.  SELECT  4  PIECES,")
Text(37,18,"  GRIND  IN  MORTAR,"
Text(46,26,"  [*USE  ALL*]"
Text(56,20,"  PRESS  [ENTER]  ")
Pause
Goto G
Lbl F
AxesOff
ClrHome:ClrDraw
Text(1,5,"***POWDERED CANDY***"
```

```
Text(10,11,"1.  OPEN  CAREFULLY")
Text(18,12,"2.  SAVE  WRAPPER")
Text(27,12,"3.  USE  TWO  TEASPOONS")
Text(36,13,"      OF POWDERED  FORM"
Text(45,26,"[*USE  ALL*]"
Text(54,20," PRESS  [ENTER] ")
Pause
Goto G
Lbl G
ClrHome:ClrDraw
AxesOff
Text(1,1,"**TO START EXPERIMENT***"
Text(9,15," SIMULTANEOUSLY  "
Text(15,14,"---------------"
Text(24,10,"1. PRESS  [ENTER]"
Text(35,10,"2. PLACE  CANDY  IN  WATER"
Text(46,10,"3.  MIX  WITH  STIRRER"
Text(55,90,"*")
For(I,1,90,5)
Text(55,90-I,"*")
End
Pause
ClrHome:ClrDraw
0 →Xmin
30 →Xmax
1 →Xscl
0 →Ymin
8 →Ymax
1 →Yscl
Full
PlotsOff
FnOff
Func
AxesOn
{1,0} →L₁
Send(L₁)
{1,1,1,0,0,1} →L₁
Send(L₁)
60→dim(L₂)
{3,1,-1,0} →L₁
Send(L₁)
60 →dim(L₂)
30 →Xmax
1 →Xscl
Text(4,1,"PH")
Text(51,79,"TIME")
```

```
For(I,1,60,1)
Get(L2,(I))
Pt-On(I,L2(I))
End
L1 →LA
L2 →LB
.5seq(X,X,0,60,1) →L1
Trace
Pause
Lbl M
LA →L1
LB →L2
Menu("PROJECT","GRAPH",5,"PH VALUES",6,"OPTIONS",7,"QUIT",C)
Pause
Lbl 5
ClrHome:ClrDraw
PlotsOff
FnOff
ZoomStat
AxesOn
0 →Xmin
30 →Xmax
1 →Xscl
0 →Ymin
8 →Ymax
1 →Yscl
Plot1(Scatter,L1,L2,•)
Text(8,3,"PH")
Text(51,79,"TIME")
Text(1,45,"TO    CONTINUE")
Text(8,45,"PRESS [ENTER]")
Text(16,54,"TWICE")
Trace
Pause
PlotsOff
Goto 7
Lbl 6
AxesOff
ClrHome:ClrDraw
max(L1) →S
min(L2) →T
max(L2) →U
L(1) →V
L(30) →W
If T<V
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```
(T-V) →H
If T≥V
(T-V) →H
Goto Y
End
Lbl Y
Text(1,1,"***-TIME  AND  PH-***")
Text(8,1,"----------")
Text(12,10,"1.  TOTAL  TIME.....",S)
Text(19,10,"2.  LOW  PH.....",T)
Text(26,10,"3.  HIGH  PH.....",U)
Text(33,10,"4.  INITIAL  PH.....",V)
Text(40,10,"5.  FINAL  PH.....",W)
Text(57,1,"*")
Text(48,10,"6.  ACIDIC  INC....",H)
For(I,1,90,5)
Text(57,1+I,"*")
End
Pause
Goto 7
Lbl C
ClrHome:ClrDraw
AxesOff
Text(1,1,"*")
Text(55,90,"*")
For(I,1,90,5)
Text(1,I,"*")
Text(55,90-I,"*")
End
For(I,1,54,6)
Text(I,2,"*")
Text(55-I,88,"*")
End
Text(27,34,"GOODBYE")
```